Seaming Apparatus

The present invention relates to a seaming apparatus, in particular an ultrasonic or laser seaming apparatus for use in joining together two or more fabric or material components without thread. The apparatus is particularly suitable for seaming garments for example protective or weatherproof and other garments such as underwear, sportswear and the like comprising materials including thermoplastic sheets or textile materials made of or including substantially thermoplastic fibres, but not exclusively.

Seaming apparatus of this type are known also as ultrasonic sewing machines though, for the avoidance of doubt, no needle and thread are used for providing a seam. Ultrasonic sewing machines are generally well known and comprise an ultrasonic horn operable to emit ultrasonic energy through a fabric/material engaging end face and a rotatable anvil support. The anvil support and the horn are arranged so as to define a "nip" between the respective fabric engaging surfaces thereof for receiving the fabric sheet materials (or components e.g. zipper fasteners) to be joined. Such apparatus is generally well known in the art and is described variously in for example, US 3852144; WO 02/49831A1; US 3785910; US 3666599; and others.

In such known apparatus fabric material is fed through the apparatus utilising the rotary motion of the aforesaid anvil (or feed) wheel but such arrangements have two fundamental disadvantages. Firstly it has been found that the bearings in such anvil wheels, being in close proximity to a very high frequency (ultrasonic) source are liable to rapid degradation and wear (including also complete bearing failure) which can result in considerable machine downtime and loss of productivity. The second particular problem associated with known apparatus is that the material to be joined is "nipped" between the anvil/anvil wheel and the resonating horn more or less substantially continuously and it will be understood that where material to be joined is being fed through such apparatus, and being "nipped" thereby, it is difficult for an operator to guide material through such a machine in such a way that significant changes in direction of the material, as it is passed through the apparatus, can be realised, or intricate seams made. Yet a further disadvantage of known systems is that the movement of the material through known apparatus can result in the material puckering resulting in seams which are uneven and/or not adequately weatherproofed, or at worst are unsightly and require the garment to be rejected as sub standard.

It is an object of the present invention to avoid or minimise one or more of the foregoing disadvantages.

The present invention provides a seaming apparatus for joining, along a seam without thread, at least two superposed flexible sheet materials, said seaming apparatus comprising bonding means for bonding together at least two flexible sheet materials, said bonding means having a nip portion for releasably engaging together sheet material in use of the apparatus; and drive means formed and arranged for engaging sheet material, in use and to be bonded, and moving incrementally sheet material through said bonding means, said drive means being formed and arranged to co-operate with said nip portion so as to sequentially nip then drive material through the apparatus wherein only one of said nip portion and said drive means is in contact with sheet material, in use of the apparatus, at any given moment.

Thus with a seaming apparatus according to the present invention it is possible to feed sheet material to be seamed together through a machine and by virtue of the discontinuous nature of the drive means engaging the sheet material it is possible, for the first time, to achieve sharp angle changes in direction in a seam and/or to form intricate seam patterns.

Preferably said bonding means comprises an ultrasonic horn structure and a welding foot (or anvil), said horn and said welding foot (or anvil) comprising said nip portion.

Alternatively there may be used a laser for bonding together said at least two superposed flexible sheet materials. Desirably where there is used a laser to bond together the material a layer of dye or other energy (radiation) absorbing material may be deposited onto the material so as to focus the laser energy to where the bonding is required. (Energy absorbing materials may also be utilised in ultrasonic bonding.)

An example of a process for laser welding using a radiation absorbing material is the patented process of The Welding Institute, Cambridge disclosed in International Patent Publication No. WO 00/20157 known as the CLEARWELD (Registered Trade Mark) technique.

The nip portion of the apparatus may further comprise a holding foot and a throat plate, said holding foot and said throat plate being formed and arranged for releasably engaging sheet material in use of the apparatus. This arrangement provides additional means of securely holding the sheet material in place during the bonding operation.

Preferably there is provided a pin portion formed and arranged to pinch the sheet material and thereby to enable a material (garment) to be pivoted round for easy manoeuvring of the seam shape. The pin portion is desirably located in

close proximity to the bonding means, preferably in alignment with the direction of feed and the bonding means. The pin portion may be conveniently attached to a moving foot of the drive means, or alternatively, can be independently mounted and actuated. The pin portion pinches the materials being joined, to hold them, at a time when they are not engaged by either the drive means or the bonding means, allowing the materials to be pivoted round to produce the desired seam shape or to correct the direction of the material through the apparatus. For some applications the pin of the pin portion may be pointed and can penetrate, or puncture, the materials to be bonded and thereby act as pivot point to facilitate the movement of material thereabout. For other applications, such as the production of water and windproof garments, it is desirable that the pin does not damage or puncture the sheet materials. In this case the pin has a contact surface at its tip that abuts and holds, but does not damage, the materials being joined when the pin portion pinches them. For example the contact surface at the tip of the pin may be a flat disc, or a hemisphere, having a sufficiently small surface area so as not to unduly impede pivoting of the pinched material therearound.

Preferably said bonding means is formed and arranged to provide a single discrete point of contact (bond) between said at least two superposed flexible sheet materials. In

practice, and desirably, there may be provided a multiplicity of discrete points of contact between sheet materials where the thermoplastic constituents of such materials have fused and joined together. Advantageously said multiplicity of discrete joins or points of contact between flexible sheet materials provides a substantially continuous and weatherproof seam for an article or garment manufactured using said seaming apparatus. Alternatively the seam produced by said seaming apparatus can be considered to be a plurality of overlapping discrete welds or fusion points which have the appearance of a continuous seam.

Any suitable form of drive means may be used, which drive means releasably engages sheet material in use of the apparatus and for driving sheet material through said bonding means. The drive means may comprise a feed gear or gears or at least one feed dog formed and arranged to cooperate with at least one corresponding moving foot, between which flexible sheet material is engaged. Said feed dog is formed and arranged to incrementally move sheet material through the bonding means, then disengage the sheet material, return in an opposite direction to that in which it was engaging the sheet material and then re-engage a next portion of sheet material. Such a feed dog arrangement may be driven by a cam arrangement to produce the required cycle of motion. Stepper motors or the like may be used to drive said feed dog or said

cam arrangement driving said feed dog. Preferably there are provided two moving feet co-operating with said feed dog.

Preferably said drive means is adjustable so as to vary the feed rate of the material through the seaming apparatus. Desirably the rate at which said nip portion of said bonding means "nips" is adjustable to correspond with any adjustments in the feed rate of the drive means, that is they are synchronised with one another. Desirably there is provided a controller means for co-ordinating operation of the drive means and the nip portion of the bonding means.

The points of contact, the contact faces, of the nip portion can be designed to impart various patterned appearances to the fabric, materials or components being joined.

The present invention also provides a method for joining, along a seam without thread, at least two superposed flexible sheet materials comprising the steps of;

a) providing a seaming apparatus according to the invention; and

b) introducing said at least two flexible sheet materials into said seaming apparatus whereby the flexible sheet materials are sequentially, nipped by the nip portion of the apparatus whilst being bonded by the bonding means, then driven

incrementally through the apparatus by the drive means, with only one of said nip portion and said drive means being in contact with the sheet material at any given moment.

Further preferred features and advantages of the present invention will appear in the following detailed description given by way of an example of some preferred embodiments illustrated with reference to the accompanying drawings in which: -

Figures 1a to d and Figs. 2 and 3 show schematically the mode of operation of a seaming apparatus according to one embodiment of the present invention;

Figures 4 to 6 show various examples of alternative embodiments of the seaming apparatus of the invention; and

Figures 7 to 18 each illustrate a cycle of feeding sheet materials through various embodiments of seaming apparatus according to the invention.

A seaming apparatus, generally indicated by reference 10, is shown schematically in Figures 1a to d. The apparatus is for joining, along a seam without a thread, two sheets 12, 14 of fabric material containing thermoplastic fibres. The apparatus 10 comprises two essential features, that of a bonding assembly and that of a drive assembly for feeding

sheet material through the apparatus. The arrow X indicates the direction of feed of the materials being bonded.

In more detail the bonding assembly comprises a welding foot 16 and an ultrasonic horn 18. In order to weld or to fuse together the two sheets of material 12, 14 the welding foot 16 is brought into contact with the static ultrasonic horn 18 and by applying high frequency vibratory (ultrasonic) energy into the fabric material containing thermoplastics, the two sheets of the material are fused and bonded together.

The drive assembly comprises two moveable feed dogs 20 (only one shown in the side view) mounted in proximity to the ultrasonic horn 18. The feed dog is provided with a driving arrangement (not shown) which causes the feed dog to move with respect to the ultrasonic horn as will be described further below. The feed dog co-operates with the moving foot 22 to grip between the moving foot 22 and the feed dog 20 the sheet material 12, 14, and to drive the sheet material through the seaming apparatus 10.

The operation of the drive assembly and the welding/bonding assembly will now be described in more detail.

As show in Figure 1a the two sheets of material 12, 14 to be bonded together are brought into contact with each other at

the left hand side of the ultrasonic horn 18. Figure 1a shows the first step of the feed cycle of the drive assembly and it will be noted that the moving foot 22 co-operates with the feed dog 20 so as to grip between the serrated surface 24 of the feed dog 20 and the underside 26 of the moving foot 22 the two sheets of material. In this position the welding foot 16 is spaced apart from the ultrasonic horn 18 in a retracted position (see also the schematic front view shown on Figure 2).

The feed dog 20 is driven laterally by a drive mechanism (not shown) from the left side of the ultrasonic horn 18 (as shown in Figure 1a) to the right hand side of the ultrasonic horn 18 as shown in Figure 1b. Figure 1b shows the end of the feed cycle of the drive assembly which has fed the sheet material across the surface 28 of the ultrasonic horn 18.

Turning now to Figure 1c, the moving foot 22 has been retracted and is now spaced apart from the sheet material 12, 14 on the surface 28 of the ultrasonic horn 18. Simultaneously the feed dog 20 has moved downwardly with respect to the ultrasonic horn and returned to the left hand side of the ultrasonic horn 18 as shown in Figure 1c. At the same time as the moving foot 22 is being retracted the welding foot 16 has come into contact with the sheet material on the surface 28 of the ultrasonic horn 18 so as to nip the

material 12, 14 and by virtue of the ultrasonic energy being transferred into the sheet material causing the sheet material to be bonded and fused together. (This is shown also on the front view shown in Figure 3 wherein the welding foot and ultrasonic horn are in contact with each other and the feed dogs are spaced apart from the two moving feet). From the position shown in Figure 1d the welding foot 16 is retracted and spaced apart from the ultrasonic horn 18 and returns to the position shown in Figure 1a. Simultaneously the feed dog 20 returns to the surface 28 of the ultrasonic horn and re-engages the underside of the next portion of the two sheet materials to be bonded and fused together, as in Figure 1a.

In essence therefore the sequence of steps comprises a feed cycle feeding the sheet material onto the ultrasonic horn followed by a bonding operation, followed by a feed operation, followed by a bonding operation and so on. Accordingly there is provided a sequence of individual or discreet weld or fusion points where the two materials have been bonded together. This sequence of discreet welds or fusion points may be discontinuous or continuous (overlapping).

In practice it is desirable that there is provided two feed dogs in a side by side relationship together with two moving

feet, again in a side by side relationship as shown in figures 2 and 3. For the avoidance of doubt the moving foot and feed dog arrangement shown with reference to Figures 1a to d show only a single moving foot and single feed dog.

Various modifications may be made to the above described embodiment without parting from the scope of the present invention. Thus there may be provided different configurations of seaming apparatus utilising either ultrasonic energy or laser radiation, where the laser or ultrasonic device is provided above or below the flexible sheet materials being joined and to the left or right of the drive means.

Figure 4A shows an embodiment where bonding is by means of an ultrasonic horn 18 and a pin portion 29 is mounted on the front of the moving foot 22 and is offset so as to be positioned in front of the welding foot 16, when considered from the direction of feed (indicated by the arrow X). In use, the pin 30 of the pin portion 29 pinches the materials 12, 14 being bonded when they are not engaged by the moving foot 22, allowing them to be pivoted about the pin 30 to produce the desired seam shape. The pin 30 is retractable into the pin portion 29 so as not to interfere with the engagement of the moving foot 22 and the feed dog 20 when they are driving sheet material through the apparatus.

Figure 4B shows a similar embodiment to that of Figure 4A except that the pin portion 29 is mounted on the rear of the moving foot 22 and is offset so as to be positioned to the rear of the welding foot 16 when considered from the direction of feed (indicated by the arrow X).

Figure 5 shows two embodiments where bonding is by means of a laser 32. The pin portion 29 is again mounted on the moving foot 22 and is positioned either in front (Figure 5A) or behind (Figure 5B) the welding foot 16.

Figure 6 shows two embodiments where bonding is by means of a laser 32 situated underneath the materials 12, 14 being bonded. Embodiments with a pin portion 29 in front (Figure 6A) or behind (Figure 6B) the welding foot 16 are shown.

In Figure 7 a series of views are shown, representing the cycle of feeding the materials 12,14 being joined through the seaming apparatus 10 and then making a bond. The embodiment shown has a pin portion 29 in front of the welding foot 16 and bonding is by means of an ultrasonic horn 18. The end elevation and schematic front views, Figures 7A and 7B, show the sheet materials 12, 14 engaged by the pin 30 in the pin portion 29 prior to engagement by the moving foot 22 and feed dog 20. The sheet materials 12, 14 can be pivoted about the

pin 30 in order to achieve the desired seam shape. Figures 7C and 7D show similar views with the moving foot 22 and feed dog 20 engaging the sheet materials to move them through the apparatus 10. In Figure 7E and 7F the moving foot 22 has disengaged from the sheet materials 12, 14 and they can again be pivoted about the pin 30 if desired. In Figures 7G and 7H the sheet materials are being bonded at a weld point 34 between the ultrasonic horn 18 and the welding foot 16, the sheet material being further secured in the nip 36 by a holding foot 38 (not shown in the end elevation) engaging a throat plate 40 at a hold point 42.

Figures 8 to 18 show the same cycle of feeding and bonding using the same views as Figure 7 but for different embodiments of seaming apparatus 10. As in Figure 7 the holding foot is not shown in the end elevation for improved clarity.

Figure 8 A-H shows an apparatus 10 similar to that shown in Figure 7 except that the bonding assembly, the ultrasonic horn 18 and the welding foot 16, is to the right rather than to the left of the moving foot 22 when viewed from in front. The holding foot 38 is correspondingly moved to the left of the moving foot 22. As in the embodiment shown in Figure 7 the pin portion 29 is mounted on the moving foot 22 and is formed and arranged so that the pin 30 is positioned in front

of the welding foot 16 when viewed from the direction of travel of the sheet materials 12, 14.

Figure 9 A-H shows an embodiment of the seaming apparatus 10 similar to that shown in Figure 7 except that the pin portion 29 is to the rear of the welding foot 16.

Figure 10 A-H shows an embodiment of the seaming apparatus 10 similar to that shown in Figure 8 except that the pin portion 29 is to the rear of the welding foot 16.

Figure 11 A-H shows the feeding and bonding cycle for an embodiment of the apparatus 10 wherein the bonding assembly is a laser 32 mounted in the welding foot 16 above the sheet materials 12, 14 to be bonded and to the left of the moving foot 16. Figures 11G and 11H show bonding being performed on the sheet materials 12,14 at the weld point 34. As in Figure 7 the pin portion 29 is mounted on the front of the moving foot 22 so as to be positioned in front of the welding foot 16, carrying the laser 32.

Figure 12 A-H shows a similar arrangement to that shown in Figure 11, except that the laser 32, mounted on the welding foot 16, is positioned to the right of the moving foot 22 when viewed from in front.

Figure 13 A-H shows an embodiment similar to that shown in Figure 11 except that the pin portion 29 is to the rear of the laser 32 mounted on the welding foot 16.

Figure 14 A-H shows an embodiment similar to that shown in Figure 12 except that the pin portion 29 is to the rear of the laser 32 mounted on the welding foot 16.

In Figure 15 A-H the feeding and bonding cycle is illustrated for an embodiment using laser bonding, where the laser 32 is sited under the sheet materials 12,14 and to the left of the feed dog 20. Bonding is made at a weld point 34 as shown in Figures 15G and 15H between the laser 32 and the welding foot 16.

Figure 16 A-H shows an embodiment similar to that shown in Figure 15 except that the laser 32 is positioned to the right of the feed dog 20.

Figure 17 A-H shows an embodiment similar to that shown in Figure 15 except that the pin portion 29 is positioned to the rear of the welding foot 16.

Figure 18 A-H shows an embodiment similar to that shown in Figure 16 except that the pin portion 29 is positioned to the rear of the welding foot 16.